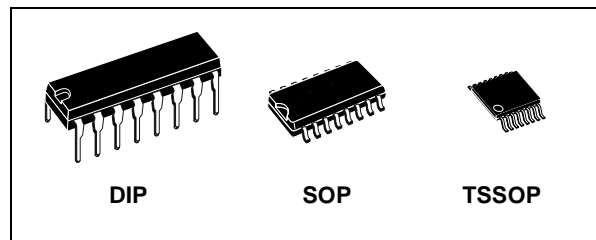




# M74HC595

## 8 BIT SHIFT REGISTER WITH OUTPUT LATCHES (3 STATE)

- HIGH SPEED:  
 $f_{MAX} = 59\text{MHz}$  (TYP.) at  $V_{CC} = 6\text{V}$
- LOW POWER DISSIPATION:  
 $I_{CC} = 4\mu\text{A}$ (MAX.) at  $T_A=25^\circ\text{C}$
- HIGH NOISE IMMUNITY:  
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 6\text{mA}$  (MIN.) FOR QA to QH  
 $|I_{OH}| = I_{OL} = 4\text{mA}$  (MIN.) FOR QH'
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \cong t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:  
 $V_{CC}$  (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 595



### ORDER CODES

| PACKAGE | TUBE        | T & R          |
|---------|-------------|----------------|
| DIP     | M74HC595B1R |                |
| SOP     | M74HC595M1R | M74HC595RM13TR |
| TSSOP   |             | M74HC595TTR    |

### DESCRIPTION

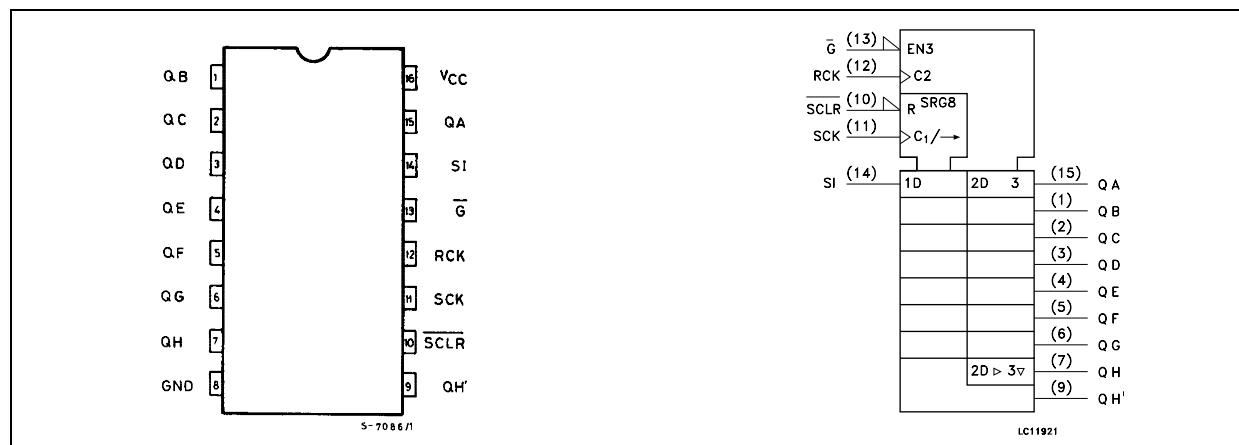
The M74HC595 is a high speed CMOS 8-BIT SHIFT REGISTERS/OUTPUT LATCHES (3-STATE) fabricated with silicon gate C<sup>2</sup>MOS technology.

This device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. The storage register has 8 3-STATE outputs. Separate clocks are provided for both the shift register and the storage register.

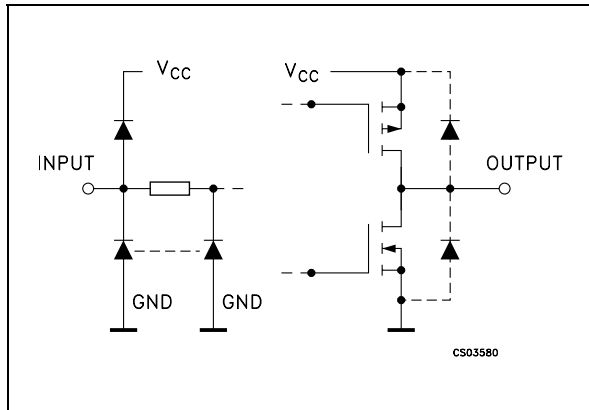
The shift register has a direct-overriding clear, serial input, and serial output (standard) pins for cascading. Both the shift register and storage register use positive-edge triggered clocks. If both clocks are connected together, the shift register state will always be one clock pulse ahead of the storage register.

All inputs are equipped with protection circuits against static discharge and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

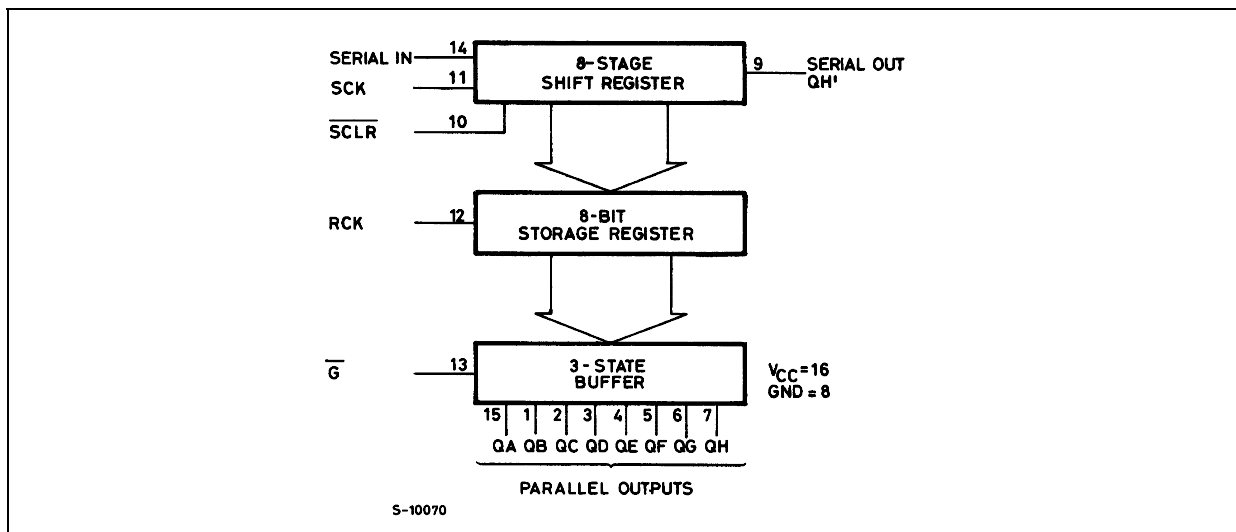
| PIN N°                  | SYMBOL          | NAME AND FUNCTION            |
|-------------------------|-----------------|------------------------------|
| 1, 2, 3, 4, 5, 6, 7, 15 | QA to QH        | Data Outputs                 |
| 9                       | QH'             | Serial Data Outputs          |
| 10                      | SCLR            | Shift Register Clear Input   |
| 11                      | SCK             | Shift Register Clock Input   |
| 13                      | $\overline{G}$  | Output Enable Input          |
| 14                      | SI              | Serial Data Input            |
| 12                      | RCK             | Storage Register Clock Input |
| 8                       | GND             | Ground (0V)                  |
| 16                      | V <sub>CC</sub> | Positive Supply Voltage      |

TRUTH TABLE

| INPUTS |     |                   |     |                | OUTPUTS   |
|--------|-----|-------------------|-----|----------------|---|
| SI     | SCK | $\overline{SCLR}$ | RCK | $\overline{G}$ |   |
| X      | X   | X                 | X   | H              | QA THRU QH OUTPUTS DISABLE  |
| X      | X   | X                 | X   | L              | QA THRU QH OUTPUTS ENABLE   |
| X      | X   | L                 | X   | X              | SHIFT REGISTER IS CLEARED   |
| L      |     | H                 | X   | X              | FIRST STAGE OF S.R. BECOMES "L" OTHER STAGES STORE THE DATA OF PREVIOUS STAGE, RESPECTIVELY |
| H      |     | H                 | X   | X              | FIRST STAGE OF S.R. BECOMES "H" OTHER STAGES STORE THE DATA OF PREVIOUS STAGE, RESPECTIVELY |
| X      |     | H                 | X   | X              | STATE OF S.R. IS NOT CHANGED  |
| X      | X   | X                 |     | X              | S.R. DATA IS STORED INTO STORAGE REGISTER   |
| X      | X   | X                 |     | X              | STORAGE REGISTER STATE IS NOT CHANGED   |

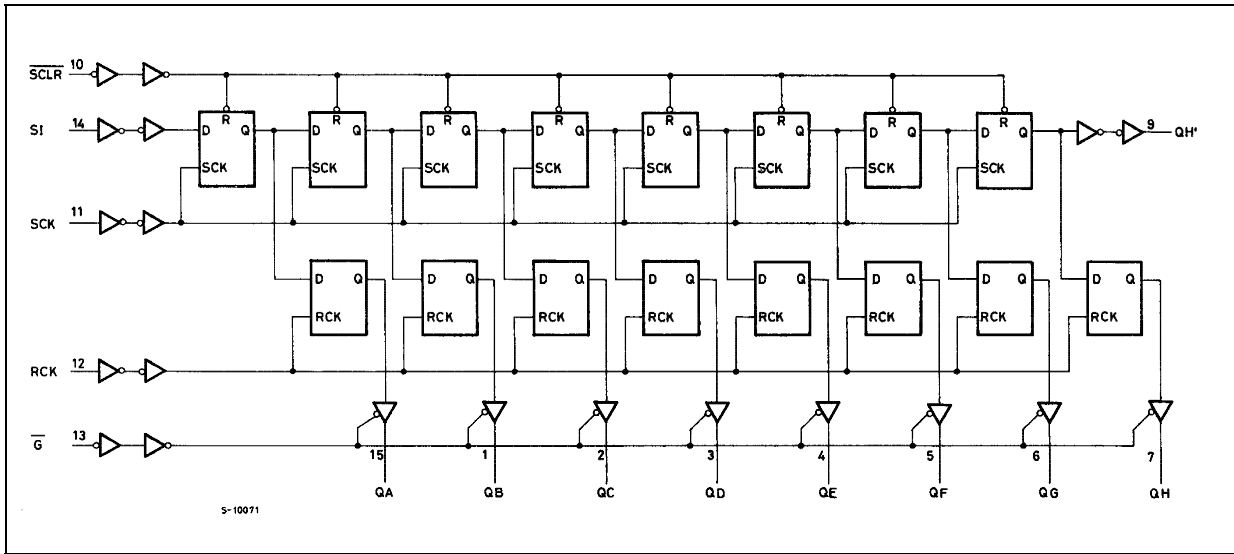
X: Don't Care

LOGIC DIAGRAM



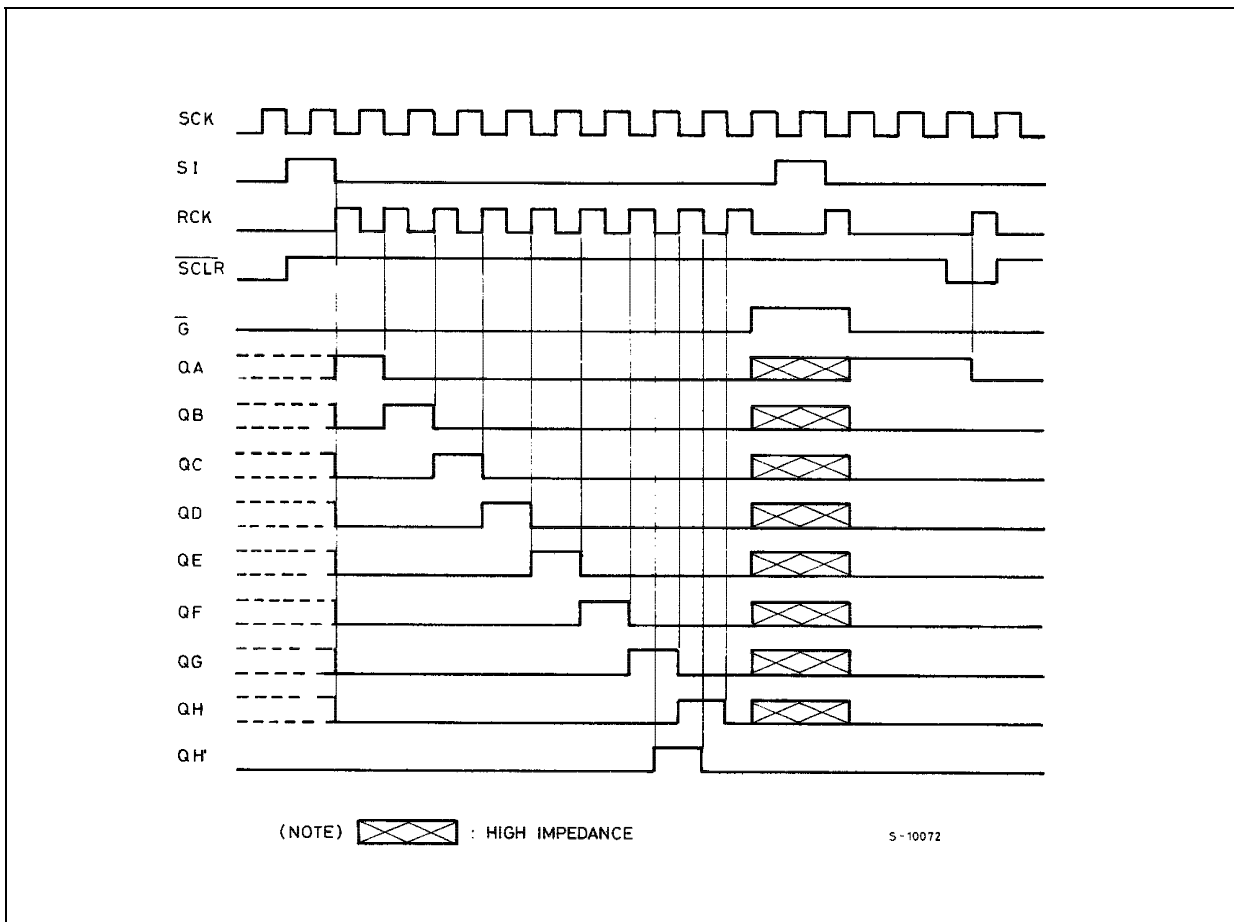
This logic diagram has not be used to estimate propagation delays

LOGIC DIAGRAM



This logic diagram has not be used to estimate propagation delays

TIMING CHART



**ABSOLUTE MAXIMUM RATINGS**

| Symbol                | Parameter                     | Value                  | Unit   |    |
|-----------------------|-------------------------------|------------------------|--------|----|
| $V_{CC}$              | Supply Voltage                | -0.5 to +7             | V      |    |
| $V_I$                 | DC Input Voltage              | -0.5 to $V_{CC} + 0.5$ | V      |    |
| $V_O$                 | DC Output Voltage             | -0.5 to $V_{CC} + 0.5$ | V      |    |
| $I_{IK}$              | DC Input Diode Current        | $\pm 20$               | mA     |    |
| $I_{OK}$              | DC Output Diode Current       | $\pm 20$               | mA     |    |
| $I_O$                 | DC Output Current             | $\pm 35$               | mA     |    |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 70$               | mA     |    |
| $P_D$                 | Power Dissipation             | DIP                    | 750(*) | mW |
|                       |                               | SOP                    | 500(*) | mW |
|                       |                               | TSSOP                  | 450(*) | mW |
| $T_{stg}$             | Storage Temperature           | -65 to +150            | °C     |    |
| $T_L$                 | Lead Temperature (10 sec)     | 300                    | °C     |    |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

(\*) Power dissipation at 65°C. Derating from 65°C to 125°C: DIP Package -10mW/°C; SO Package -7mW/°C; TSSOP Package -6.1mW/°C.

**RECOMMENDED OPERATING CONDITIONS**

| Symbol     | Parameter                | Value           | Unit      |    |
|------------|--------------------------|-----------------|-----------|----|
| $V_{CC}$   | Supply Voltage           | 2 to 6          | V         |    |
| $V_I$      | Input Voltage            | 0 to $V_{CC}$   | V         |    |
| $V_O$      | Output Voltage           | 0 to $V_{CC}$   | V         |    |
| $T_{op}$   | Operating Temperature    | -55 to 125      | °C        |    |
| $t_r, t_f$ | Input Rise and Fall Time | $V_{CC} = 2.0V$ | 0 to 1000 | ns |
|            |                          | $V_{CC} = 4.5V$ | 0 to 500  | ns |
|            |                          | $V_{CC} = 6.0V$ | 0 to 400  | ns |

## DC SPECIFICATIONS

| Symbol          | Parameter   | Test Condition         |  | Value                 |      |       |             |      |              | Unit |      |
|-----------------|---|------------------------|--|-----------------------|------|-------|-------------|------|--------------|------|------|
|                 |   | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |       | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |   |                        |  | Min.                  | Typ. | Max.  | Min.        | Max. | Min.         |      | Max. |
| V <sub>IH</sub> | High Level Input Voltage                            | 2.0                    |  | 1.5                   |      |       | 1.5         |      | 1.5          |      | V    |
|                 |   | 4.5                    |  | 3.15                  |      |       | 3.15        |      | 3.15         |      |      |
|                 |   | 6.0                    |  | 4.2                   |      |       | 4.2         |      | 4.2          |      |      |
| V <sub>IL</sub> | Low Level Input Voltage                             | 2.0                    |  |                       |      | 0.5   |             | 0.5  |              | 0.5  | V    |
|                 |   | 4.5                    |  |                       |      | 1.35  |             | 1.35 |              | 1.35 |      |
|                 |   | 6.0                    |  |                       |      | 1.8   |             | 1.8  |              | 1.8  |      |
| V <sub>OH</sub> | High Level Output Voltage<br>(for QH' outputs)      | 2.0                    | I <sub>O</sub> =-20 μA   | 1.9                   | 2.0  |       | 1.9         |      | 1.9          |      | V    |
|                 |   | 4.5                    | I <sub>O</sub> =-20 μA   | 4.4                   | 4.5  |       | 4.4         |      | 4.4          |      |      |
|                 |   | 6.0                    | I <sub>O</sub> =-20 μA   | 5.9                   | 6.0  |       | 5.9         |      | 5.9          |      |      |
|                 |   | 4.5                    | I <sub>O</sub> =-4.0 mA  | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |      |
|                 |   | 6.0                    | I <sub>O</sub> =-7.8 mA  | 5.68                  | 5.8  |       | 5.63        |      | 5.60         |      |      |
| V <sub>OH</sub> | High Level Output Voltage<br>(for QA to QH outputs) | 2.0                    | I <sub>O</sub> =-20 μA   | 1.9                   | 2.0  |       | 1.9         |      | 1.9          |      | V    |
|                 |   | 4.5                    | I <sub>O</sub> =-20 μA   | 4.4                   | 4.5  |       | 4.4         |      | 4.4          |      |      |
|                 |   | 6.0                    | I <sub>O</sub> =-20 μA   | 5.9                   | 6.0  |       | 5.9         |      | 5.9          |      |      |
|                 |   | 4.5                    | I <sub>O</sub> =-6.0 mA  | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |      |
|                 |   | 6.0                    | I <sub>O</sub> =-7.8 mA  | 5.68                  | 5.8  |       | 5.63        |      | 5.60         |      |      |
| V <sub>OL</sub> | Low Level Output Voltage<br>(for QH' outputs)       | 2.0                    | I <sub>O</sub> =20 μA  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  | V    |
|                 |   | 4.5                    | I <sub>O</sub> =20 μA  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |
|                 |   | 6.0                    | I <sub>O</sub> =20 μA  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |
|                 |   | 4.5                    | I <sub>O</sub> =4.0 mA   |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |      |
|                 |   | 6.0                    | I <sub>O</sub> =7.8 mA   |                       | 0.18 | 0.26  |             | 0.33 |              | 0.40 |      |
| V <sub>OL</sub> | Low Level Output Voltage<br>(for QA to QH outputs)  | 2.0                    | I <sub>O</sub> =20 μA  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  | V    |
|                 |   | 4.5                    | I <sub>O</sub> =20 μA  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |
|                 |   | 6.0                    | I <sub>O</sub> =20 μA  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |
|                 |   | 4.5                    | I <sub>O</sub> =6.0 mA   |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |      |
|                 |   | 6.0                    | I <sub>O</sub> =7.8 mA   |                       | 0.18 | 0.26  |             | 0.33 |              | 0.40 |      |
| I <sub>I</sub>  | Input Leakage Current                               | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND  |                       |      | ± 0.1 |             | ± 1  |              | ± 1  | μA   |
| I <sub>OZ</sub> | High Impedance Output Leakage Current               | 6.0                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = V <sub>CC</sub> or GND |                       |      | ± 0.5 |             | ± 5  |              | ± 10 | μA   |
| I <sub>CC</sub> | Quiescent Supply Current                            | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND  |                       |      | 4     |             | 40   |              | 80   | μA   |

AC ELECTRICAL CHARACTERISTICS ( $C_L = 50 \text{ pF}$ , Input  $t_r = t_f = 6 \text{ ns}$ )

| Symbol              | Parameter                           | Test Condition  |               |                           | Value                    |      |      |                                    |      |                                     | Unit |      |
|---------------------|-------------------------------------|-----------------|---------------|---------------------------|--------------------------|------|------|------------------------------------|------|-------------------------------------|------|------|
|                     |                                     | $V_{CC}$<br>(V) | $C_L$<br>(pF) |                           | $T_A = 25^\circ\text{C}$ |      |      | $-40 \text{ to } 85^\circ\text{C}$ |      | $-55 \text{ to } 125^\circ\text{C}$ |      |      |
|                     |                                     |                 |               |                           | Min.                     | Typ. | Max. | Min.                               | Max. | Min.                                |      | Max. |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time (Qn)         | 2.0             | 50            |                           |                          | 25   | 60   |                                    | 75   |                                     | 90   | ns   |
|                     |                                     | 4.5             |               |                           | 7                        | 12   |      | 15                                 |      | 18                                  |      |      |
|                     |                                     | 6.0             |               |                           | 6                        | 10   |      | 13                                 |      | 15                                  |      |      |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time (QH')        | 2.0             | 50            |                           |                          | 30   | 75   |                                    | 95   |                                     | 115  | ns   |
|                     |                                     | 4.5             |               |                           | 8                        | 15   |      | 19                                 |      | 23                                  |      |      |
|                     |                                     | 6.0             |               |                           | 7                        | 13   |      | 16                                 |      | 20                                  |      |      |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (SCK - QH')  | 2.0             | 50            |                           |                          | 45   | 125  |                                    | 155  |                                     | 190  | ns   |
|                     |                                     | 4.5             |               |                           | 15                       | 25   |      | 31                                 |      | 38                                  |      |      |
|                     |                                     | 6.0             |               |                           | 13                       | 21   |      | 26                                 |      | 32                                  |      |      |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (SCLR - QH') | 2.0             | 50            |                           |                          | 60   | 175  |                                    | 220  |                                     | 265  | ns   |
|                     |                                     | 4.5             |               |                           | 18                       | 35   |      | 44                                 |      | 53                                  |      |      |
|                     |                                     | 6.0             |               |                           | 15                       | 30   |      | 37                                 |      | 45                                  |      |      |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (RCK - Qn)   | 2.0             | 50            |                           |                          | 60   | 150  |                                    | 190  |                                     | 225  | ns   |
|                     |                                     | 4.5             |               |                           | 20                       | 30   |      | 38                                 |      | 45                                  |      |      |
|                     |                                     | 6.0             |               |                           | 17                       | 26   |      | 32                                 |      | 38                                  |      |      |
|                     |                                     | 2.0             | 150           |                           |                          | 75   | 190  |                                    | 240  |                                     | 285  | ns   |
|                     |                                     | 4.5             |               |                           | 25                       | 38   |      | 48                                 |      | 57                                  |      |      |
|                     |                                     | 6.0             |               |                           | 22                       | 32   |      | 41                                 |      | 48                                  |      |      |
| $t_{PZL}$ $t_{PZH}$ | High Impedance Output Enable Time   | 2.0             | 50            | $R_L = 1 \text{ K}\Omega$ |                          | 45   | 135  |                                    | 170  |                                     | 205  | ns   |
|                     |                                     | 4.5             |               |                           |                          | 15   | 27   |                                    | 34   |                                     | 41   |      |
|                     |                                     | 6.0             |               |                           |                          | 13   | 23   |                                    | 29   |                                     | 35   |      |
|                     |                                     | 2.0             | 150           | $R_L = 1 \text{ K}\Omega$ |                          | 60   | 175  |                                    | 220  |                                     | 265  | ns   |
|                     |                                     | 4.5             |               |                           |                          | 20   | 35   |                                    | 44   |                                     | 53   |      |
|                     |                                     | 6.0             |               |                           |                          | 17   | 30   |                                    | 37   |                                     | 45   |      |
| $t_{PLZ}$ $t_{PHZ}$ | High Impedance Output Disable Time  | 2.0             | 50            | $R_L = 1 \text{ K}\Omega$ |                          | 30   | 150  |                                    | 190  |                                     | 225  | ns   |
|                     |                                     | 4.5             |               |                           |                          | 15   | 30   |                                    | 38   |                                     | 45   |      |
|                     |                                     | 6.0             |               |                           |                          | 14   | 26   |                                    | 32   |                                     | 38   |      |
| $f_{MAX}$           | Maximum Clock Frequency             | 2.0             | 50            |                           | 6.0                      | 17   |      | 4.8                                |      | 4                                   |      | MHz  |
|                     |                                     | 4.5             |               |                           | 30                       | 50   |      | 24                                 |      | 20                                  |      |      |
|                     |                                     | 6.0             |               |                           | 35                       | 59   |      | 28                                 |      | 24                                  |      |      |
|                     |                                     | 2.0             | 150           |                           | 5.2                      | 14   |      | 4.2                                |      | 3.4                                 |      | MHz  |
|                     |                                     | 4.5             |               |                           | 26                       | 40   |      | 21                                 |      | 17                                  |      |      |
|                     |                                     | 6.0             |               |                           | 31                       | 45   |      | 25                                 |      | 20                                  |      |      |
| $t_{W(H)}$          | Minimum Pulse Width (SCK, RCK)      | 2.0             | 50            |                           |                          | 17   | 75   |                                    | 95   |                                     | 110  | ns   |
|                     |                                     | 4.5             |               |                           | 6                        | 15   |      | 19                                 |      | 22                                  |      |      |
|                     |                                     | 6.0             |               |                           | 6                        | 13   |      | 16                                 |      | 19                                  |      |      |
| $t_{W(L)}$          | Minimum Pulse Width (SCLR)          | 2.0             | 50            |                           |                          | 20   | 75   |                                    | 95   |                                     | 110  | ns   |
|                     |                                     | 4.5             |               |                           | 6                        | 15   |      | 19                                 |      | 22                                  |      |      |
|                     |                                     | 6.0             |               |                           | 6                        | 13   |      | 16                                 |      | 19                                  |      |      |
| $t_s$               | Minimum Set-up Time (SI - CCK)      | 2.0             | 50            |                           |                          | 25   | 50   |                                    | 65   |                                     | 75   | ns   |
|                     |                                     | 4.5             |               |                           | 5                        | 10   |      | 13                                 |      | 15                                  |      |      |
|                     |                                     | 6.0             |               |                           | 4                        | 9    |      | 11                                 |      | 13                                  |      |      |
| $t_s$               | Minimum Set-up Time (SCK - RCK)     | 2.0             | 50            |                           |                          | 35   | 75   |                                    | 95   |                                     | 110  | ns   |
|                     |                                     | 4.5             |               |                           | 8                        | 15   |      | 19                                 |      | 22                                  |      |      |
|                     |                                     | 6.0             |               |                           | 6                        | 13   |      | 16                                 |      | 19                                  |      |      |

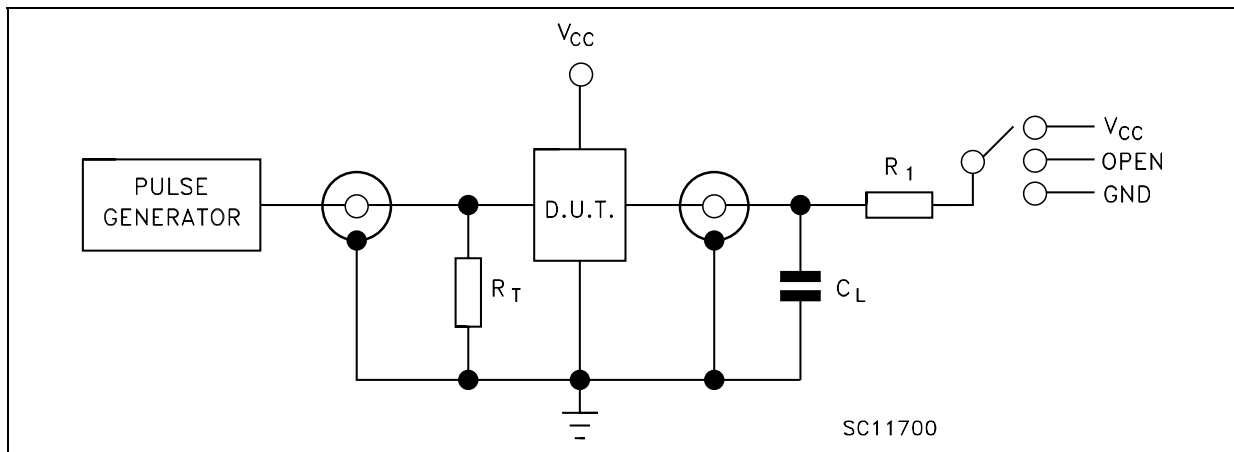
| Symbol           | Parameter                        | Test Condition      |                     |  | Value                 |      |      |             |      |              | Unit |      |    |
|------------------|----------------------------------|---------------------|---------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|----|
|                  |                                  | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |    |
|                  |                                  |                     |                     |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |    |
| t <sub>s</sub>   | Minimum Set-up Time (SCRL - RCK) | 2.0                 | 50                  |  |                       | 40   | 100  |             |      | 125          |      | 145  | ns |
|                  |                                  | 4.5                 |                     |  |                       | 10   | 20   |             |      | 25           |      | 29   |    |
|                  |                                  | 6.0                 |                     |  |                       | 7    | 17   |             |      | 21           |      | 25   |    |
| t <sub>h</sub>   | Minimum Hold Time                | 2.0                 | 50                  |  |                       |      |      | 0           |      | 0            |      | 0    | ns |
|                  |                                  | 4.5                 |                     |  |                       |      |      | 0           |      | 0            |      | 0    |    |
|                  |                                  | 6.0                 |                     |  |                       |      |      | 0           |      | 0            |      | 0    |    |
| t <sub>REM</sub> | Minimum Clear Removal Time       | 2.0                 | 50                  |  |                       | 15   | 50   |             |      | 65           |      | 75   | ns |
|                  |                                  | 4.5                 |                     |  |                       | 3    | 10   |             |      | 13           |      | 15   |    |
|                  |                                  | 6.0                 |                     |  |                       | 3    | 9    |             |      | 11           |      | 13   |    |

**CAPACITIVE CHARACTERISTICS**

| Symbol          | Parameter                              | Test Condition      |  |  | Value                 |      |      |             |      |              | Unit |      |    |
|-----------------|--|---------------------|--|--|-----------------------|------|------|-------------|------|--------------|------|------|----|
|                 |  | V <sub>CC</sub> (V) |  |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |    |
|                 |  |                     |  |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |    |
| C <sub>IN</sub> | Input Capacitance                      |                     |  |  |                       | 5    | 10   |             |      | 10           |      | 10   | pF |
| C <sub>PD</sub> | Power Dissipation Capacitance (note 1) |                     |  |  |                       | 184  |      |             |      |              |      |      | pF |

1) C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. I<sub>CC(opr)</sub> = C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> + I<sub>CC</sub>

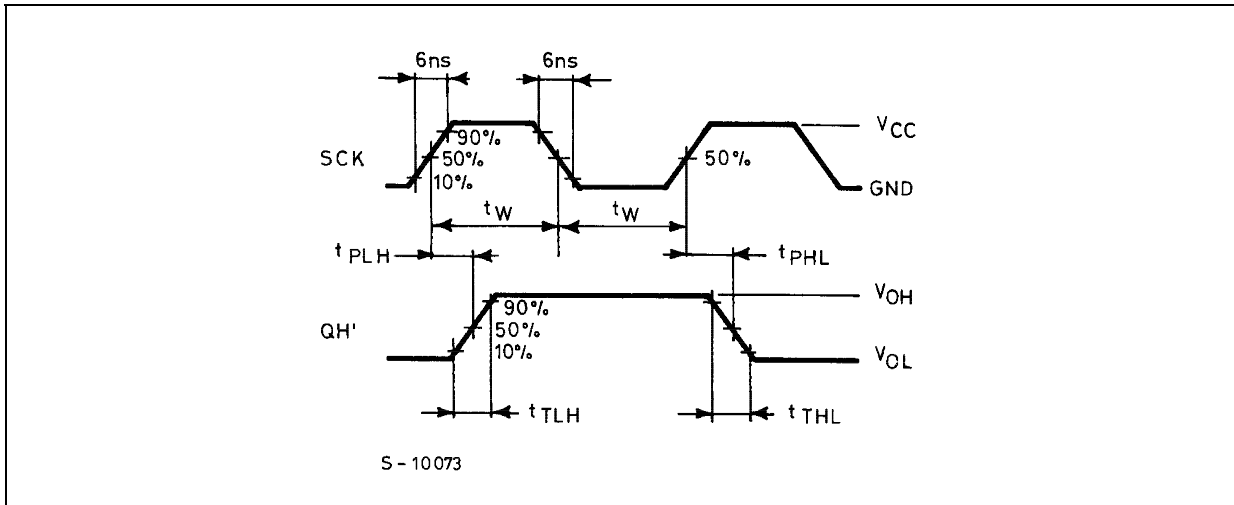
**TEST CIRCUIT**



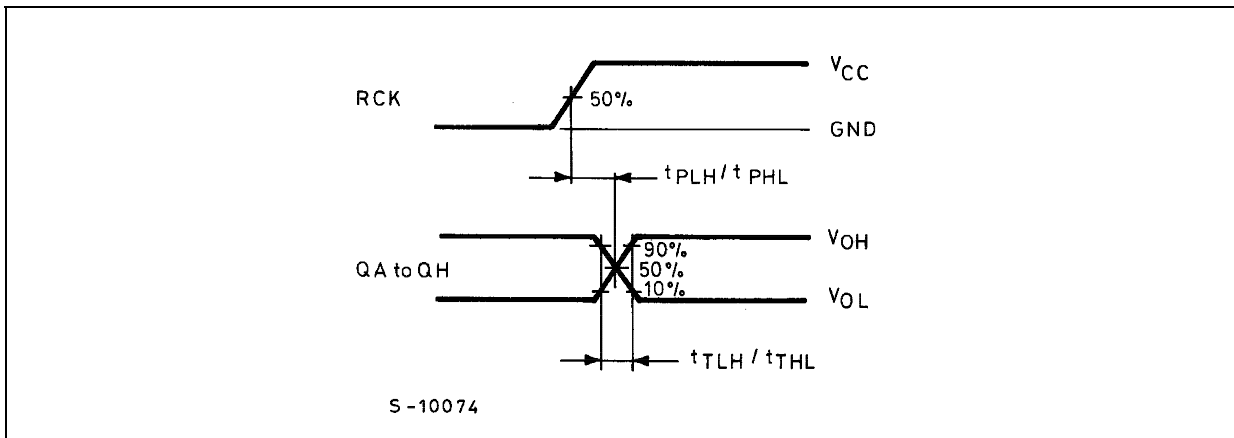
| TEST                                | SWITCH          |
|-------------------------------------|-----------------|
| t <sub>PLH</sub> , t <sub>PHL</sub> | Open            |
| t <sub>PZL</sub> , t <sub>PLZ</sub> | V <sub>CC</sub> |
| t <sub>PZH</sub> , t <sub>PHZ</sub> | GND             |

C<sub>L</sub> = 50pF/150pF or equivalent (includes jig and probe capacitance)  
R<sub>1</sub> = 1KΩ or equivalent  
R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

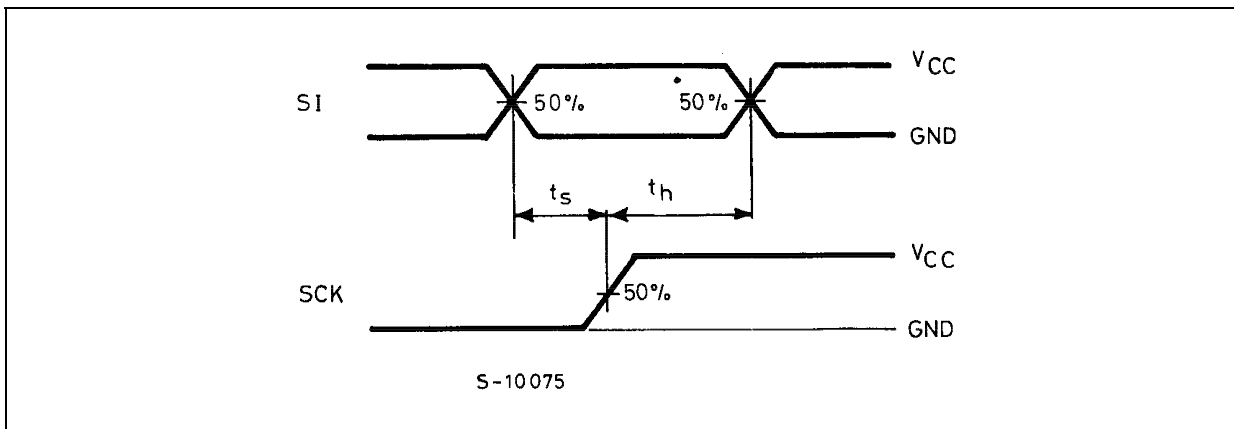
**WAVEFORM 1: SCK TO QH' PROPAGATION DELAY TIMES, SCK MINIMUM PULSE WIDTH**  
 (f=1MHz; 50% duty cycle)



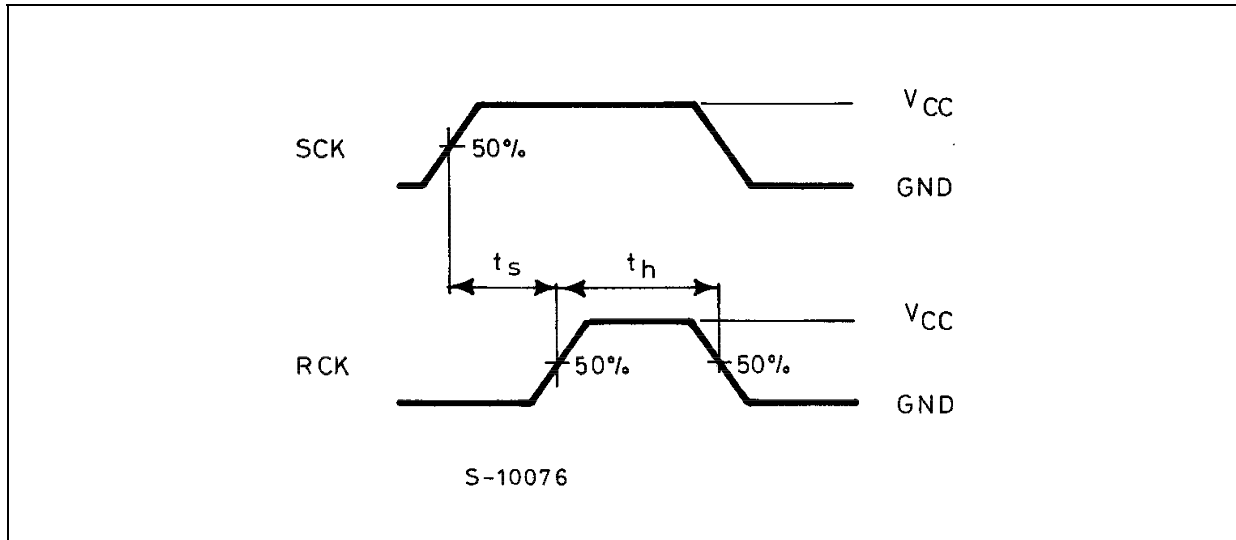
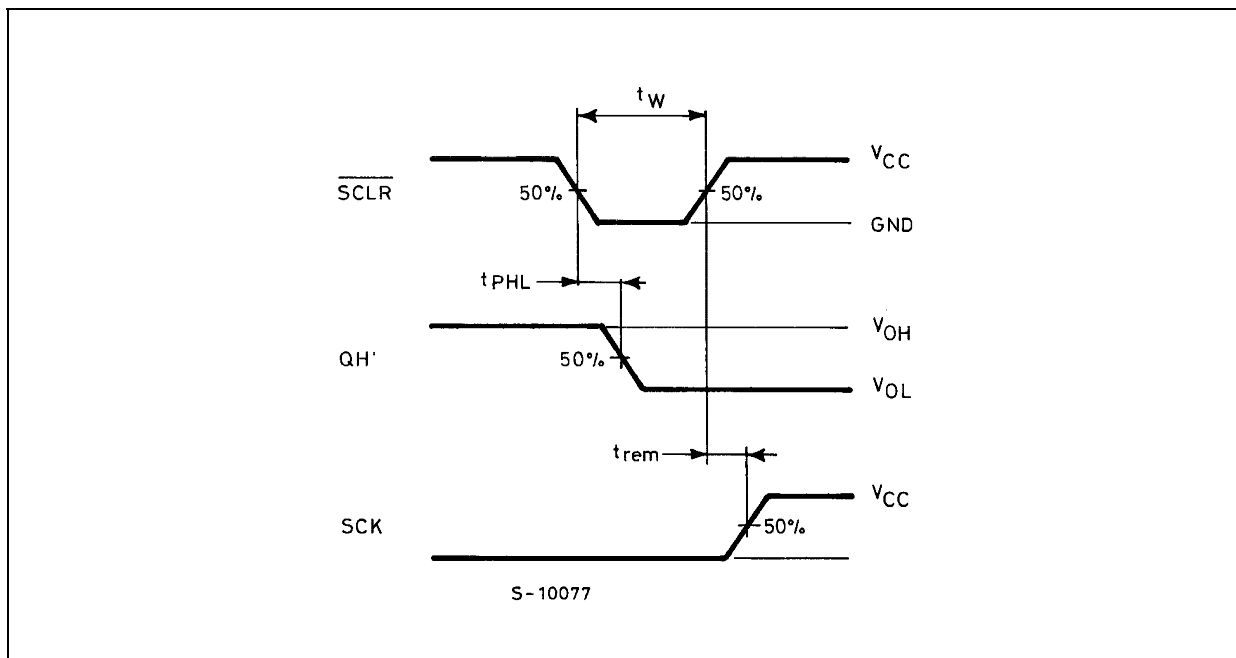
**WAVEFORM 2: RCK TO Qn PROPAGATION DELAY TIMES** (f=1MHz; 50% duty cycle)



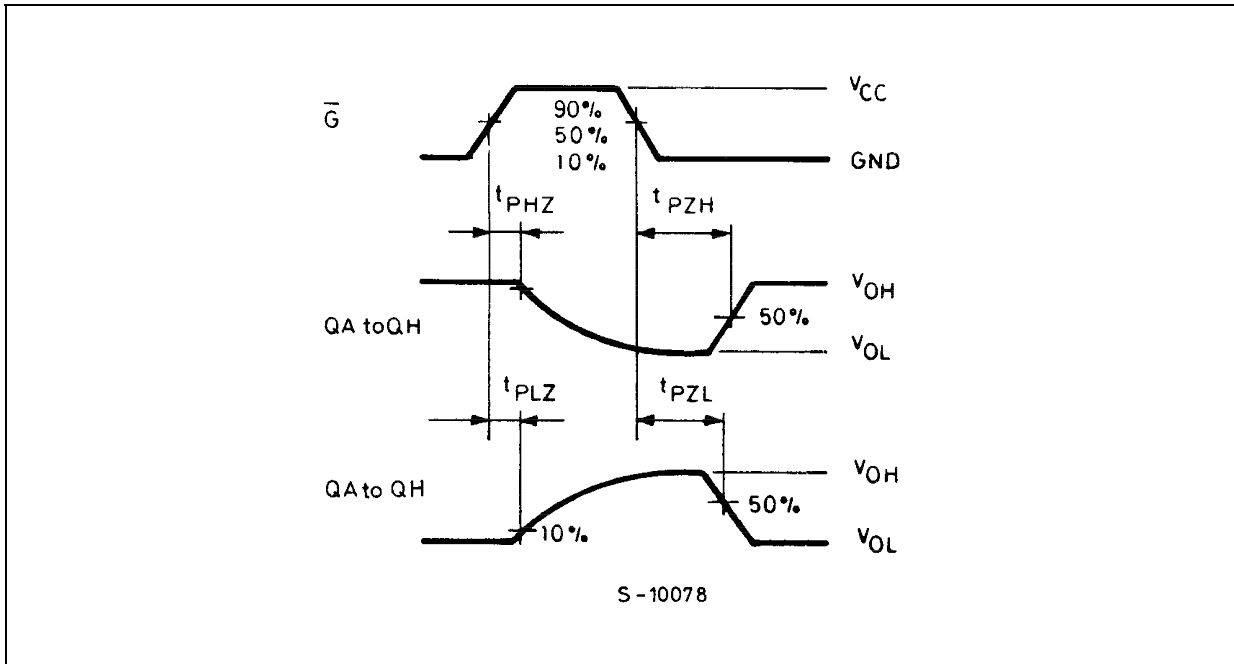
**WAVEFORM 3: SI TO SCK SETUP AND HOLD TIMES** (f=1MHz; 50% duty cycle)



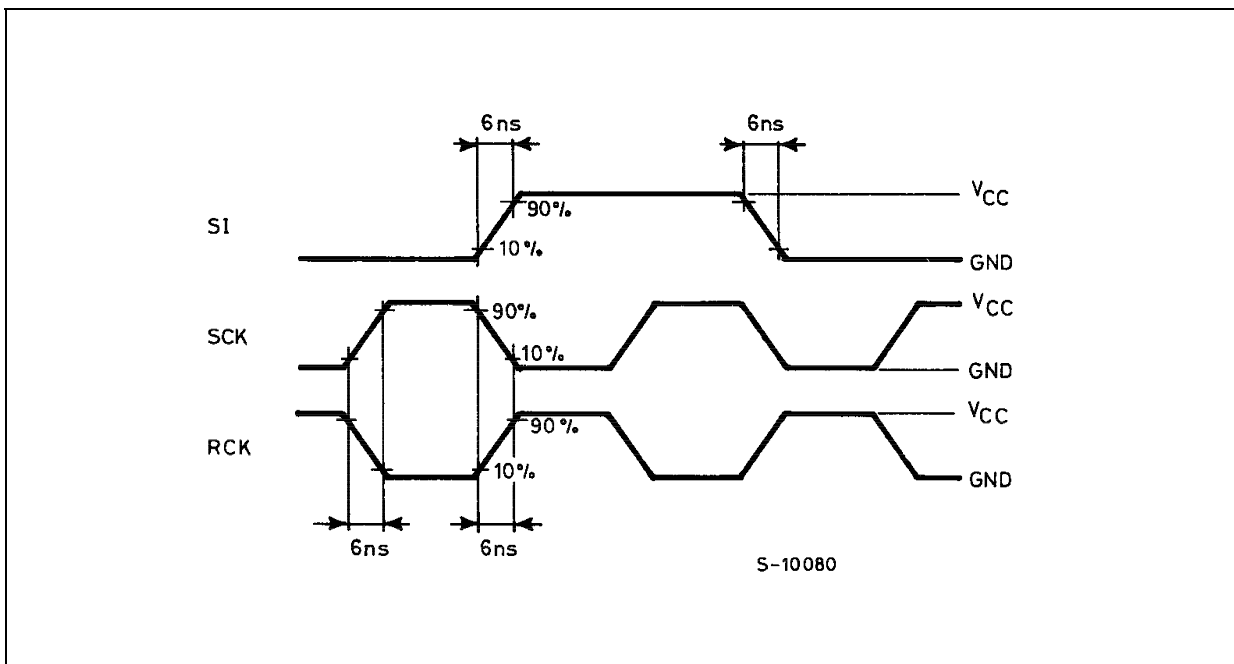


**WAVEFORM 4: SCK TO RCK SETUP AND HOLD TIMES** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 5:  $\overline{\text{SCLR}}$  MINIMUM PULSE WIDTH, MINIMUM REMOVAL TIME**  
( $f=1\text{MHz}$ ; 50% duty cycle)

WAVEFORM 6: OUTPUT ENABLE AND DISABLE TIMES (f=1MHz; 50% duty cycle)

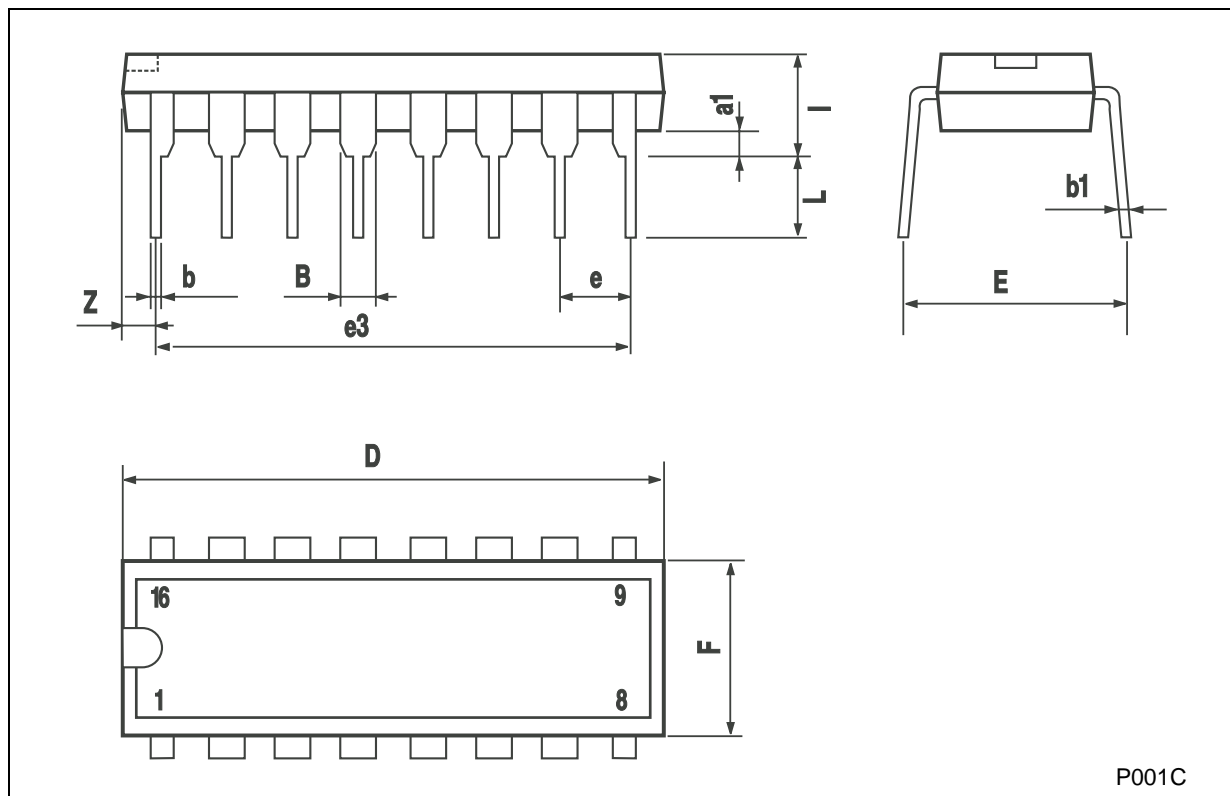


WAVEFORM 7: INPUT WAVEFORM (f=1MHz; 50% duty cycle)



### Plastic DIP-16 (0.25) MECHANICAL DATA

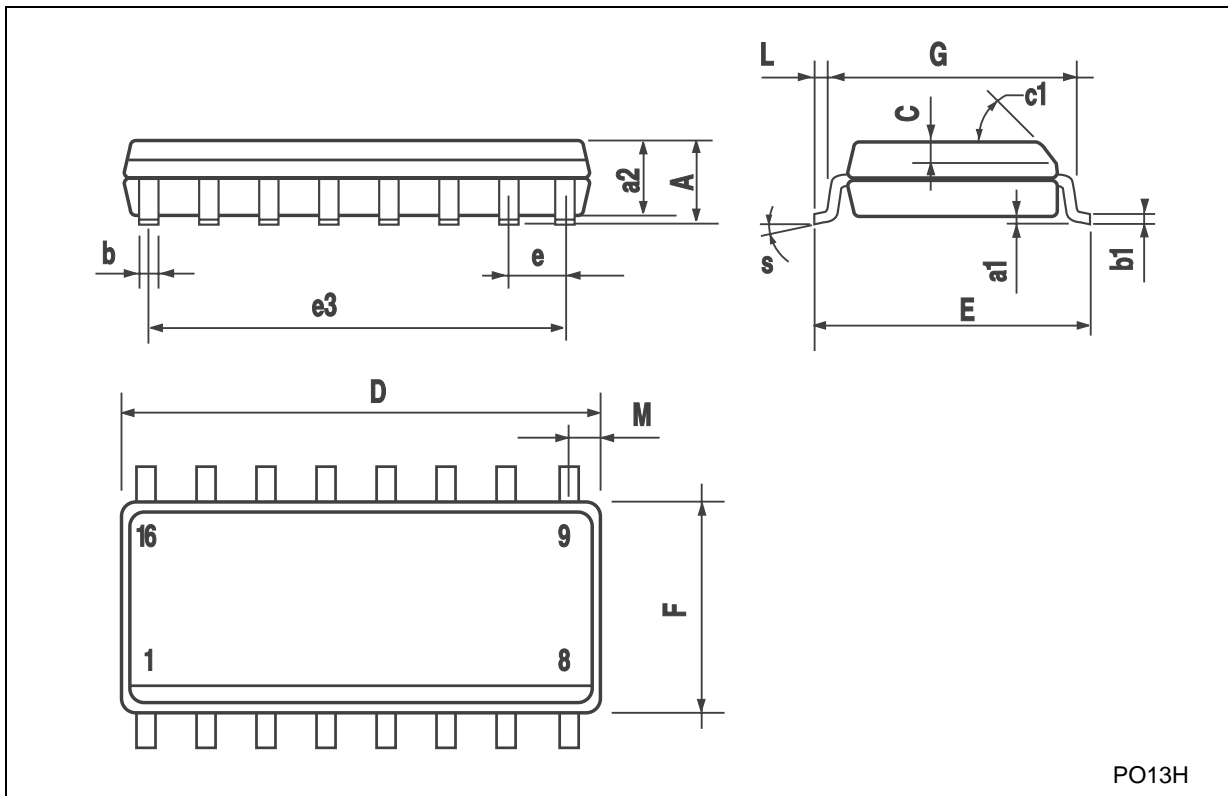
| DIM. | mm.  |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP   | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.77 |       | 1.65 | 0.030 |       | 0.065 |
| b    |      | 0.5   |      |       | 0.020 |       |
| b1   |      | 0.25  |      |       | 0.010 |       |
| D    |      |       | 20   |       |       | 0.787 |
| E    |      | 8.5   |      |       | 0.335 |       |
| e    |      | 2.54  |      |       | 0.100 |       |
| e3   |      | 17.78 |      |       | 0.700 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    |      |       | 1.27 |       |       | 0.050 |



P001C

**SO-16 MECHANICAL DATA**

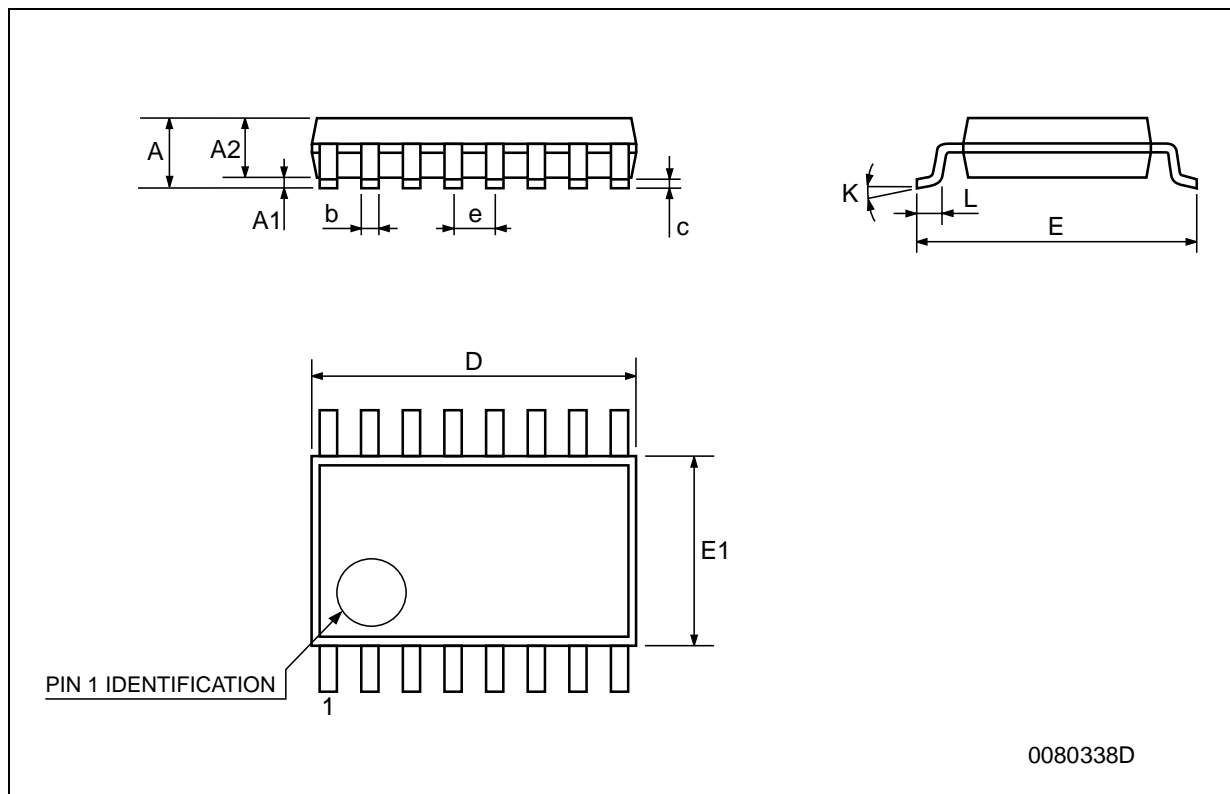
| DIM. | mm.        |      |      | inch     |       |       |
|------|------------|------|------|----------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.     | TYP.  | MAX.  |
| A    |            |      | 1.75 |          |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.004    |       | 0.008 |
| a2   |            |      | 1.65 |          |       | 0.064 |
| b    | 0.35       |      | 0.46 | 0.013    |       | 0.018 |
| b1   | 0.19       |      | 0.25 | 0.007    |       | 0.010 |
| C    |            | 0.5  |      |          | 0.019 |       |
| c1   | 45° (typ.) |      |      |          |       |       |
| D    | 9.8        |      | 10   | 0.385    |       | 0.393 |
| E    | 5.8        |      | 6.2  | 0.228    |       | 0.244 |
| e    |            | 1.27 |      |          | 0.050 |       |
| e3   |            | 8.89 |      |          | 0.350 |       |
| F    | 3.8        |      | 4.0  | 0.149    |       | 0.157 |
| G    | 4.6        |      | 5.3  | 0.181    |       | 0.208 |
| L    | 0.5        |      | 1.27 | 0.019    |       | 0.050 |
| M    |            |      | 0.62 |          |       | 0.024 |
| S    | 8          |      |      | ° (max.) |       |       |



PO13H

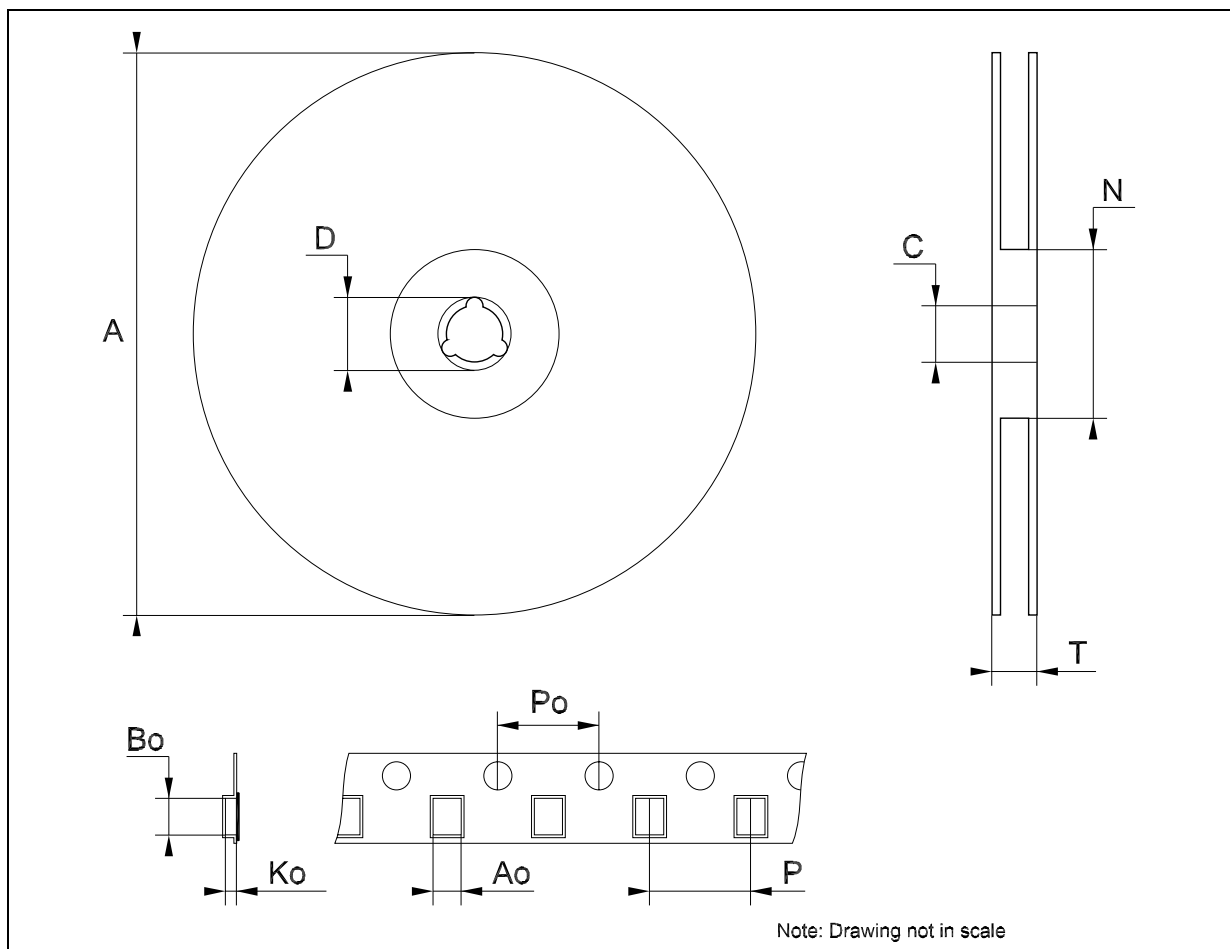
## TSSOP16 MECHANICAL DATA

| DIM. | mm.  |          |      | inch  |            |        |
|------|------|----------|------|-------|------------|--------|
|      | MIN. | TYP      | MAX. | MIN.  | TYP.       | MAX.   |
| A    |      |          | 1.2  |       |            | 0.047  |
| A1   | 0.05 |          | 0.15 | 0.002 | 0.004      | 0.006  |
| A2   | 0.8  | 1        | 1.05 | 0.031 | 0.039      | 0.041  |
| b    | 0.19 |          | 0.30 | 0.007 |            | 0.012  |
| c    | 0.09 |          | 0.20 | 0.004 |            | 0.0079 |
| D    | 4.9  | 5        | 5.1  | 0.193 | 0.197      | 0.201  |
| E    | 6.2  | 6.4      | 6.6  | 0.244 | 0.252      | 0.260  |
| E1   | 4.3  | 4.4      | 4.48 | 0.169 | 0.173      | 0.176  |
| e    |      | 0.65 BSC |      |       | 0.0256 BSC |        |
| K    | 0°   |          | 8°   | 0°    |            | 8°     |
| L    | 0.45 | 0.60     | 0.75 | 0.018 | 0.024      | 0.030  |



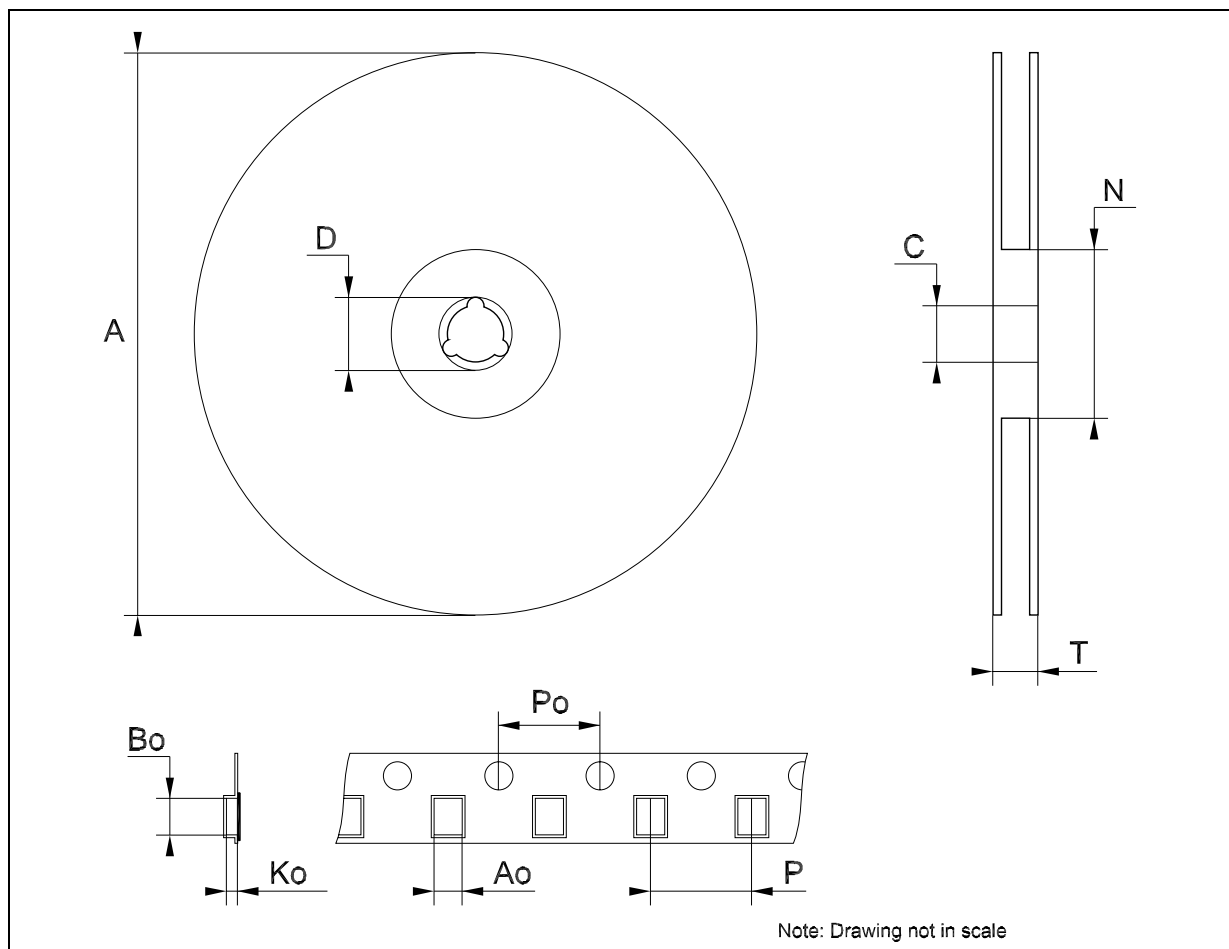
**Tape & Reel SO-16 MECHANICAL DATA**

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 22.4 |       |      | 0.882  |
| Ao   | 6.45 |     | 6.65 | 0.254 |      | 0.262  |
| Bo   | 10.3 |     | 10.5 | 0.406 |      | 0.414  |
| Ko   | 2.1  |     | 2.3  | 0.082 |      | 0.090  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |      | 0.319  |



### Tape & Reel TSSOP16 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 22.4 |       |      | 0.882  |
| Ao   | 6.7  |     | 6.9  | 0.264 |      | 0.272  |
| Bo   | 5.3  |     | 5.5  | 0.209 |      | 0.217  |
| Ko   | 1.6  |     | 1.8  | 0.063 |      | 0.071  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |      | 0.319  |



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